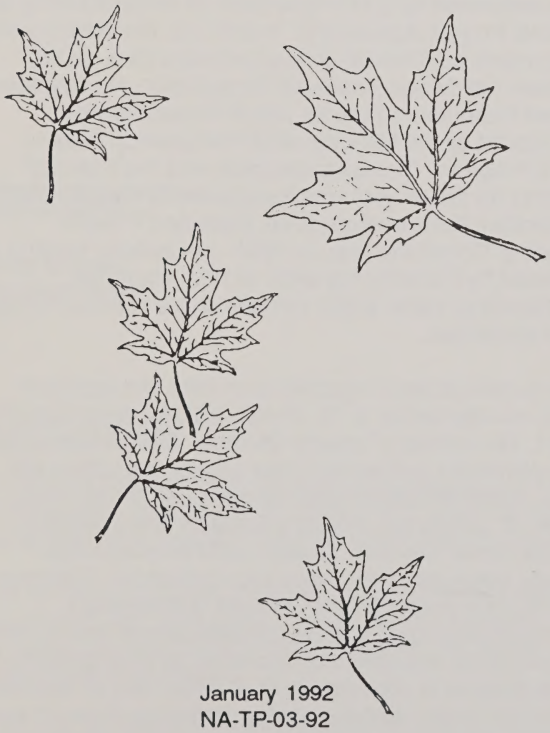
United States
Department of
Agriculture

Forest Service

Northeastern Area
State & Private Forestry

Forestry Canada
Forêts Canada

Sugar Maple Crown Conditions Improve Between 1988 and 1990



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INTRODUCTION

During the late 1970's and throughout the 1980's, sugarbush managers and foresters who managed northern hardwood stands became concerned about sugar maple decline. The problem was most severe in Quebec Province. A working group of scientists recommended that a special project be designed to monitor and evaluate sugar maple condition, particularly in relation to pollution and stand management intensity. The North American Sugar Maple Decline Project was formed in 1987 between Canada and the United States and authorized by a Memorandum Of Understanding and Special Project Agreement. In the U.S. the initial funding and project administration was provided through the Eastern Hardwood Research Cooperative, Northeastern Forest Experiment Station, USDA Forest Service, sponsored by the National Acid Precipitation Assessment Program. The administration and the financial support for the project was transferred to Forest Health Protection, Northeastern Area, State and Private Forestry, Forest Service, in 1991. In Canada, funding is provided by Forestry Canada. In both countries, participating states and provinces share in some of the local expenses.

The current project is guided by a Joint Management Team co-chaired by G. D. Hertel, USDA Forest Service, and L. W. Carlson, Forestry Canada. Seven states and four provinces cooperate in the project and collect the data. National Coordinators provide day-to-day guidance: D. Lachance, Forestry Canada, and I. Millers, USDA Forest Service. Quality assurance is a high priority because of the many data collectors. Common training is provided by the National Coordinators. Remeasurements are done between crews, states, and provinces for evaluation by the National Coordinators. Data analysis is provided by D. C. Allen and C. Barnett, State University, College of Environmental Science and Forestry, Syracuse, New York (Barnett has transferred to the Northeastern Forest Experiment Station).

OBJECTIVES

The objectives of the project are to determine:

1. the rate of change in sugar maple tree condition ratings from 1988 to 1990.

2. if the rate of change in sugar maple tree condition ratings are different among:

   a. various levels of sulfate and nitrate wet deposition.
   b. sugarbush and undisturbed forest.
   c. various levels of initial stand decline conditions.

3. the possible causes of sugar maple decline and the geographical relationships between potential causes and extent of decline.

PLOT ESTABLISHMENT

A total of 171 plot-clusters (5 plots each) are distributed throughout North America from Wisconsin and Ontario to Massachusetts and Nova Scotia (Fig. 1):

United States		Canada	
Maine	18	New Brunswick	12
Massachusetts	10	Nova Scotia	2
Michigan	10	Ontario	24
New Hampshire	6	Quebec	24
New York	18		
Vermont	29		
Wisconsin	18		

One-half of the plot-clusters within a state or province are active sugarbushes and one-half are in unmanaged forests. Unmanaged forests are stands that have not had any disturbance caused by management activity since 1983. Local regions chose the stands at various initial stand decline conditions. The region includes a variety of site conditions and covers most of the prime sugar maple growing areas. In 1988, annual sulfate wet deposition ranged from 10 to 35 kg/ha (9 to 31 lbs/ac), and nitrate wet deposition ranged from about 8 to 15 kg/ha (7 to 13 lbs/ac).

Each plot-cluster consists of five 20- x 20-m plots (66- x 66-ft) located in a sugar maple stand 50 to 150 years old. The average sugarbush has approximately 150 trees per acre (393 trees/ha), 78% of which are sugar maple, and the average tree diameter at breast height (d.b.h.) is 11 inches (28 cm). The unmanaged stands have about

one-third more trees, 68% of which are sugar maples, with a slightly smaller average d.b.h. of 10 inches. Each sample tree is marked with a numbered metal tag at d.b.h.

Observations are made on about 15,000 trees, of which approximately 70% or 11,000 are sugar maples. More than one-half of the sugar maples are in the dominant or codominant crown positions. The other more common species are American beech, yellow birch, red maple, and ash.

Sugar maple crowns are evaluated annually for branch dieback, foliage transparency and discoloration, dwarfed foliage, and insect defoliation. The incidence of these stress indicators fluctuate from year to year, probably as a result of individual tree response to changes in weather and site conditions. However, continued monitoring will reveal long-term trends in forest health and possibly disclose the impact of disturbances such as global warming, air pollution, defoliation, drought, or a combination of these.

Quality and consistency of data are assured through annual training and certification of field crews. At least 5% of crown ratings are remeasured to assess measurement variability. Over 90% of remeasurements in 1988 fell within the prescribed standards. This improved to about 95% in 1989 and 1990.

ANALYSIS

In 1990, 171 plot-clusters were examined and used to describe the 1990 sugar maple conditions. However, the changes are based on comparison of sugar maples in 165 plot-clusters only, established in 1988 and remeasured in 1990. The other, remaining plot-clusters had been established later as replacements for logged ones, or other more recently established plots.

The results presented here are based on the analyses of crown conditions for about 7,000 upper canopy sugar maples (dominant and codominant trees). Branch dieback in the upper crown is a disease condition caused by various stresses. For our purposes, up to 5% dieback is considered normal; 6% to 15% indicates moderate damage; and more than 15% dieback indicates serious damage. The abundance of foliage is another measure of tree vigor. It is measured as transparency; that is, the amount of light coming through the crown. Transparency of 25% or less is normal, 26% to 55% indicates a moderately thin crown, and a higher transparency indicates low tree vigor.

Pollution effects were analyzed by comparing 1990 averages of sulfate wet deposition from stands in high, moderate, and low zones. These zones were identified from computer-generated maps based on annual sulfate wet deposition during the last decade.

Foliage discoloration and dwarfed foliage was rated, but the incidence was low. So, no detailed analyses of these characteristics are presented.

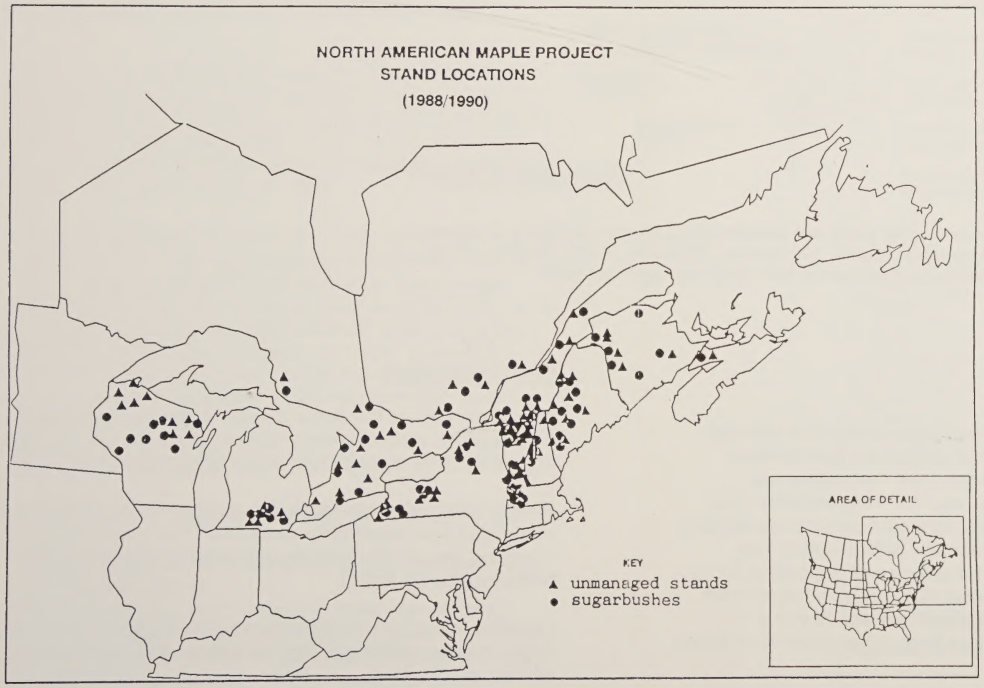

Figure 1.--Distribution of plot-clusters in the North American Sugar Maple Project.

SUGAR MAPLE CONDITIONS IN 1990 AND CHANGES SINCE 1988

Dieback

The average stand dieback of sugar maples in 1990 was 7% in sugarbushes and 6% in unmanaged sugar maple stands (Fig. 2). The annual average percentage of stand dieback for sugar maples during the 3-year period was:

Year	Sugarbush	Unmanaged
1988	9 (+/-0.4)	7 (+/-0.4)
1989	8 (+/-0.4)	6 (+/-0.3)
1990	7 (+/-0.4)	6 (+/-0.3)

The proportion of upper canopy sugar maples rated with significant crown damage (more than 15% dieback) in 1990 was 5.6% in sugarbushes and 4.1% in unmanaged stands (Fig. 3). This was a decrease from the 10.7% in sugarbushes and the 7.3% in unmanaged stands recorded in 1988.

The sugar maples with bole injury tended to have more dieback. Approximately 86% of the sugar maples with more than 50% dieback had major bole and root damage.

No significant differences in average stand dieback percentages were found in sugarbushes among states

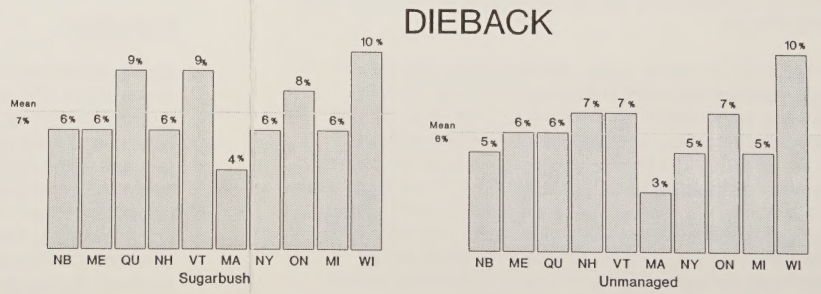

Figure 2.--Average percentage of sugar maple dieback in 1990 in North American Maple Decline Project--by states and provinces and stand management class.

and provinces in 1990 (Fig. 2). Some differences among regions were observed for unmanaged stands. Wisconsin had the highest average dieback (10%) and it was significantly higher than the averages in Maine, Massachusetts, Michigan, New Brunswick, New York, and Quebec. On the other hand, Massachusetts had the lowest average dieback (3%), and it was significantly lower than that in Ontario, New Hampshire, Vermont and Wisconsin.

Crown dieback rating changes of two or more classes (20%) are considered biologically significant. Between 1988 and 1990, overall, 7% of the trees improved by two or more classes and 3% declined by two or more classes in sugarbushes. In unmanaged stands, 5% improved and 2% declined by two rating classes (Fig. 4). Most of the states and provinces experienced improvement, except Ontario, where fewer trees improved than declined by two or more rating classes. In Ontario, severe drought and forest tent caterpillar defoliation may have contributed to increased dieback.

Transparency

The average stand transparency for upper canopy sugar maples in 1990 was 15% in sugarbushes and 14% in unmanaged stands (Fig. 5). The annual average transparency percentage between 1988 through 1990 was:

Year	Sugarbush	Unmanaged
1988	18 (+/-0.8)	16 (+/-0.8)
1989	10 (+/-0.6)	19 (+/-0.6)
1990	15 (+/-0.6)	14 (+/-0.5)

Average stand transparency in sugarbushes was highest in Wisconsin (20%), and lowest in Michigan (9%) (Fig. 5). The differences were significant between the two states, but not with the other states and provinces. In unmanaged stands, again Wisconsin had the highest average transparency (22%), and Michigan had the lowest (8%) (Fig. 5).

In 1988, 21.3% of the upper canopy sugar maples in sugarbushes were rated with more than 25% transparency, but in 1990 this declined to 7.4% (Fig. 6). In unmanaged stands, the percentage decreased from 17.8% to 5.2%. Transparency of one-quarter of the sugar maples improved by two classes (20%) or more from 1988 to 1990 (Fig. 4). Transparency improved in most states, except New Brunswick, Maine, Michigan, and Wisconsin. The latter had the greatest decline in transparency. Continued drought may have contributed to the decline observed in sugarbush and unmanaged stands.

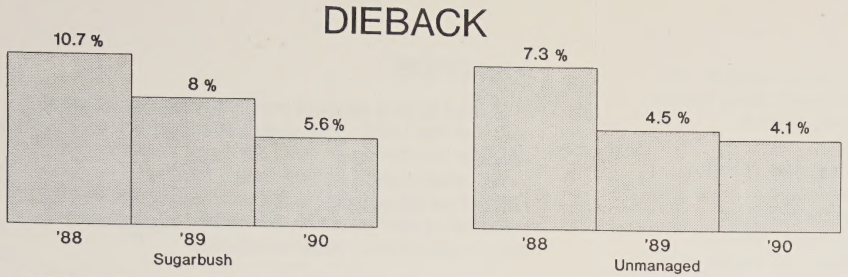

Figure 3.--Annual mean percentage of sugar maples with 16% or more dieback in the North American Maple Decline Project by stand management class.

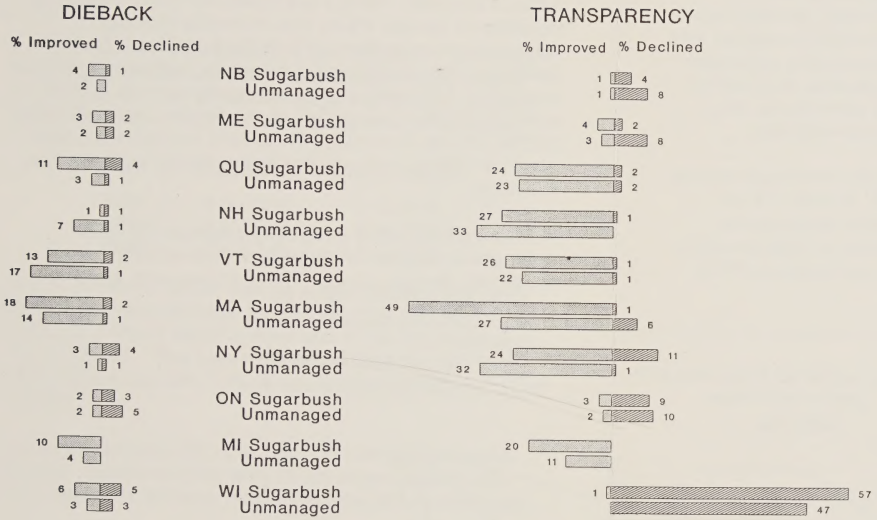

Figure 4.--Percentage of sugar maples rated two classes (20%) higher (declined) or lower (improved) for dieback and transparency in 1990 than in 1988 in the North American Sugar Maple Decline Project--by states and provinces and stand management class.

Pollution

No significant differences were found between average percentages of sugar maple dieback for plot-clusters (stands) in the high, moderate, and low sulfate wet deposition zones (6%, 7%, and 7%, respectively). The average stand sugar maple transparency was significantly better--crowns appeared denser--in high sulfate wet deposition areas than in low sulfate wet deposition areas (12% and 17%, respectively). There was no significant difference in the percentage of trees with high transparency; that is, greater than 25%, among the three zones of sulfate wet deposition.

DISCUSSION

More than 90% of the sugar maples examined are considered healthy. Approximately 86% of the sugar maples with more than 50% dieback had major bole and root damage.

The condition of sugar maples in stands managed for sap production was essentially no different from stands classified as unmanaged, though statistically some minor differences were found.

Likewise, no important differences were observed between sugar maples growing in high vs. light sulfate wet deposition zones.

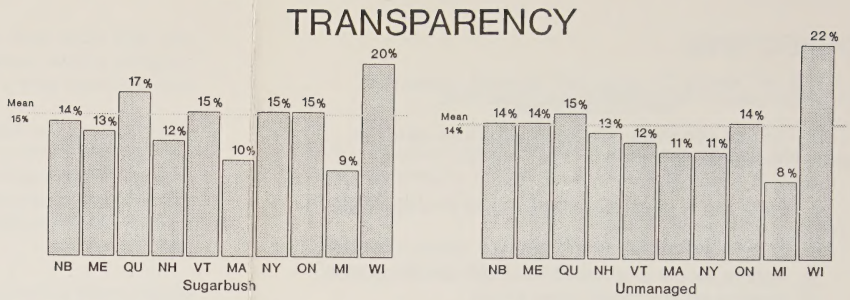

Figure 5.--Average percentage of sugar maple transparency in 1990 in North American Maple Project--by states and provinces and stand management class.

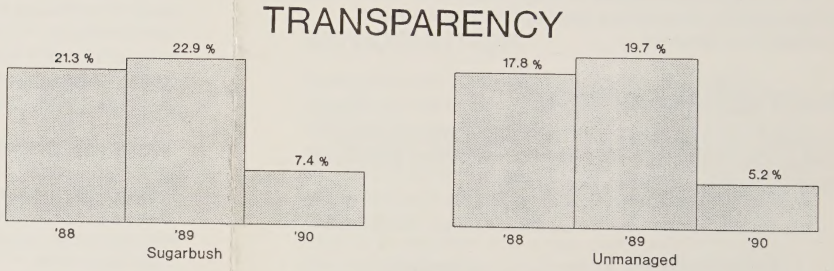

Figure 6.--Annual mean percentage of sugar maples with 26% or greater transparency in the North American Maple Project by stand management class.

Most of the crown condition improvements seem to be related to decreased insect damage from pear thrips in Massachusetts and Vermont and forest tent caterpillar in northern Ontario. Wisconsin sugar maple crowns had higher dieback and thinner crowns, probably as the result of the drought that began in 1988.

In 1990, sugar maples in areas of high sulfate wet deposition had an average transparency that was significantly lower--crowns appeared healthier--than that of sugar maples in low deposition areas. However, the differences are not significant biologically since all three areas are within the same 10% transparency class. In addition, insect defoliation and drought may have contributed damage that masked differences between high and low pollution areas.

CONCLUSIONS

- Overall, sugar maple conditions improved from 1988 to 1990.
- Sugar maple health is similar between sugarbush and unmanaged stands.
- Sulfate wet deposition seems to have had no major effect on sugar maple in the areas sampled.
- Insect defoliation and drought apparently caused adverse effects on sugar maple crown condition.